(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 May 2005 (26.05.2005)

PCT

(10) International Publication Number
WO 2005/047652 A1

(51) International Patent Classification[7]: E21D 21/00

(21) International Application Number: PCT/SE2004/001536

(22) International Filing Date: 22 October 2004 (22.10.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0302999-8 13 November 2003 (13.11.2003) SE

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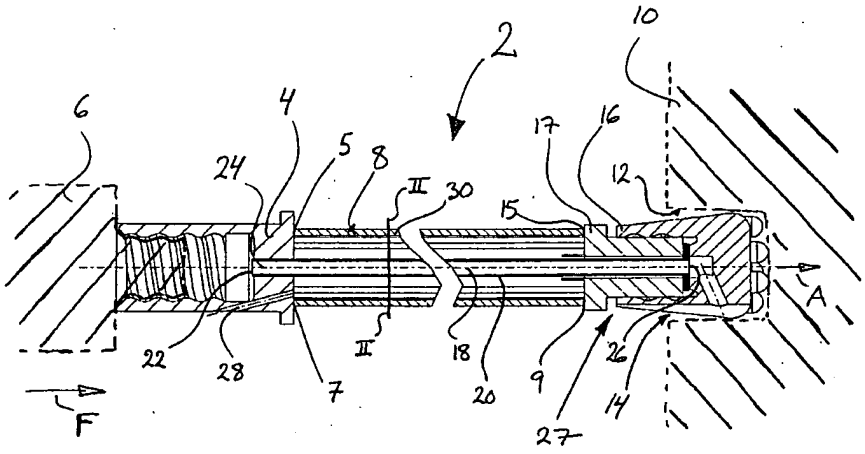
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SELF-DRILLING ROCK BOLT



(57) Abstract: The invention relates to a self-drilling rock bolt comprising an intermediate expandable part (8) joined at its first end to a connector part (4) and at its second end to a drill bit unit (27), where said connector part (4) abuts against the first axial end surface (7) of said expandable part (8) thereby forming a first contact region (5), and where said drill bit unit (27) abuts against the second axial end surface (9) of said expandable part (8) thereby forming a second contact region (15), and where said expandable part (8), said first contact region (5), and said second contact region (15) all have cross-sections that at least partly overlap each other when seen axially along said rock bolt (2), thereby allowing axial forces during a hammer drilling operation to propagate in an essentially axial direction from said connector part (4) via said expandable part (8) into said drill bit unit (27) thus improving the axial stability of the rock bolt (2).

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SELF-DRILLING ROCK BOLT

Technical area

The present invention relates to a self-drilling rock bolt.

Background of the invention

Different types of rock bolts, for example for supporting of the rock in order to increase its stability or for anchorage of suspension hooks or the like to the rock, are used for different types of rock. If the rock is solid, then a hole is usually drilled into the rock using a rock drill. Thereafter, the rock drill is removed from the hole and a rock bolt is subsequently inserted into the hole. If, on the other hand, the rock is non-solid, i.e. it comprises a multitude of cracks and the like, the hole will not remain fully open when the rock drill is removed thereby making it impossible to insert a rock bolt into the hole due to blocking rock material. In order to be able to arrange a rock bolt in non-solid rock usually a rock bolt of the self-drilling type is used, i.e. a rock bolt comprising a drill bit mounted thereon which drill bit is left in the rock together with the rock bolt, whereby the hole will remain free from blocking rock material due to the fact that no removal of the drill bit takes place.

A self-drilling rock bolt is shown in the Japanese patent application No. 2000-373505, which rock bolt comprises, in series, a rod for connecting the self-drilling rock bolt to a drilling apparatus, an expandable bolt part, and a drill bit unit comprising a holder for a drill bit and a drill bit, respectively. A drilling water supply pipe with a first end opening in the centre of rotation of the connector rod and a second opening on the surface of the drill bit extends from

the connector rod, through the inside the expandable part and to the drill bit unit.

A drawback with the rock bolt mentioned above is that both end regions of said expandable part are unable to be subjected to large axial forces during the hammer drilling operation due to the construction of the joints between said end regions and the holder for the drill bit and the connector rod, respectively, whereby said drilling water supply pipe has to be strong enough to withstand any large axial drilling forces.

Summary of the invention

It is an object of this invention to solve the problem of improving the axial stability of the joints between the end regions of the expandable part in a rock bolt and the drill bit unit and the connector rod, respectively, by arranging a self-drilling rock bolt comprising an intermediate expandable part joined at its first end to a connector part and at its second end to a drill bit unit, where said connector part abuts against the first axial end surface of said expandable part thereby forming a first contact region, said drill bit unit abuts against the second axial end surface of said expandable part, thereby forming a second contact region, and that said expandable part, said first contact region, and said second contact region all have cross-sections that at least partly overlap each other when seen axially along said rock bolt.

By arranging a self-drilling rock bolt comprising the features in independent claim 1, axial forces during a hammer drilling operation can propagate in an essentially axial direction from

said connector part via said expandable part into said drill bit unit thus improving the axial stability of the rock bolt as the joints between the end regions of the expandable part and the drill bit unit and the connector rod, respectively, are able to withstand large axial forces without collapsing.

Further preferred features are included in the dependent claims.

By arranging a self-drilling rock bolt comprising the features in dependent claims, drilling fluid is delivered without difficulty to the drill bit unit.

List of figures

The invention is now described by way of a preferred non-limiting example with reference to the appended drawings, wherein:

Figure 1 shows a longitudinal section of a self-drilling rock bolt according to one embodiment of the invention.

Figure 2 shows a cross-section of a self-drilling rock bolt along line II-II in figure 1.

Figure 3 shows a view of a self-drilling rock bolt according to figure 1.

Detailed description of preferred embodiments

Figure 1 shows a longitudinal section of a self-drilling rock bolt 2 according to one embodiment of the invention. The self-drilling rock bolt 2 comprises at least three main parts: firstly, a connector part 4 intended for connecting the rock bolt 2 to a drilling apparatus 6; secondly, an expandable part 8 intended to be expanded after the rock bolt 2 has been fully inserted in position within the rock 10 in order to lock said rock bolt 2 mechanically to the internal radial surface 12 of the hole 14 drilled into the rock 10; and thirdly, a drill bit unit 27 which may comprise one part only or more than one part. The drill bit unit 27 may thus comprise on one hand only a drill bit 16 intended to be used for drilling the hole 14 into the rock 10, or on the other hand a holder 17 for a drill bit 16 and a drill bit 16, respectively.

In the following description of the preferred embodiment of the invention, the drill bit unit 27 comprises a holder 17 for a drill bit 16 and a drill bit 16, respectively, where one end of said intermediate expandable part 8 is joined to the holder 17.

The problem of improving the axial stability of the joints at 7 and 9 between the end regions of the expandable part 8 in a rock bolt 2 and the holder 17 for the drill bit 16 and the connector part 4, respectively, are solved according to the invention by arranging a self-drilling rock bolt 2 where said parts 4,8,17 are aligned and joined together in a way that allows the axial forces F during a hammer drilling operation to propagate in an essentially axial direction A through said parts 4,8,17, thus maximizing the stability of said joints at 7,9. The intermediate expandable part 8 is joined at its first end to a connector part 4 and at its second end to a holder 17

for a drill bit 16. Said connector part 4 abuts against the first axial end surface 7 of said expandable part 8 thereby forming a first contact region 5, and said holder 17 for the drill bit 16 abuts against the second axial end surface 9 of said expandable part 8 thereby forming a second contact region 15. Said expandable part 8, said first contact region 5, and said second contact region 15 all have cross-sections that at least partly overlap each other when seen axially along said rock bolt 2, thereby allowing axial forces during a hammer drilling operation to propagate in an essentially axial direction from said connector part 4 via said expandable part 8 into said holder 17 for the drill bit 16, thus improving the axial stability of the rock bolt 2. Said expandable part 8 is preferably joined to said connector part 4 and said holder 17 for said drill bit 16, respectively, by welding but it is also possible to use another joining method, e.g. soldering or an adhesive if the resulting joint becomes sufficiently strong. Welding methods that may be used comprises, but are not limited to, resistance welding, friction welding and electron beam welding.

In order to be able to transport drilling fluid 18, usually water 18, from said drilling apparatus 6 or any other fluid source to the holder 17 for the drill bit 16, a fourth part consisting of a drilling fluid supply pipe 20 with a first end opening 22 in the centre of rotation 24 of the connector part 4 and a second opening 26 on the surface of the holder 17 for the drill bit 16 may also be arranged within the rock bolt 2, the drilling fluid supply pipe 20 thus extending from the connector part 4, through the inside the expandable part 8 and to the holder 17 for the drill bit 16.

Due to the enhanced stability of the expandable part 8 of the rock bolt 2 it is also possible to omit the drilling fluid

supply pipe 20 and to let the drilling fluid 18 use the expandable part 8 as a pipe. In this case some means for closing off the second opening 26 must be arranged on the surface of the holder 17 or in the drill bit 16. Otherwise, expanding said expandable part 8 will be difficult as the expanding fluid 28 will continuously keep leaking out through said second opening 26 thus making it difficult to build up a preferred expanding pressure in the expanding fluid 28 situated within said expandable part 8. The pressure in the drilling fluid 18 is much lower than that in the expanding fluid 28. Therefore, the closing off of said second opening 26 may for example be executed using a ball (not shown) which is conveyed into the expandable part 8 of the rock bolt 2 via the first end opening 22 in the connector part 4 together with the drilling fluid 18 and thus conveyed all the way to said second opening 26 where it gets stuck as the diameter of the ball is larger than the diameter of said second opening 26 or the opening in the drill bit 16. Other means for closing off said second opening 26 includes among others to arrange a pressure or rotation controlled vent (not shown) in the second opening 26 or in the drill bit 16 which vent closes when the pressure in the expandable part 8 exceeds a threshold. Thus, when the expanding fluid 28 is conveyed at a high pressure into the expandable part 8 it closes said vent thus expanding the walls 30 of the expandable part 8 until they come into contact with the radial surface 12 inside the drill hole 14. The expanding fluid and the drilling fluid may be the same fluid such as water fed from the same fluid source, or two different fluids such as liquid concrete and water fed from two different fluid sources.

Figure 2 shows a cross-section of the self-drilling rock bolt 2 along line II-II in figure 1. Both the outer periphery 32 and the inner periphery 34 of the expandable part 8 of said rock bolt 2 has a symmetrical cross-section forming a cross-like shape having an inner channel 11 also with a cross-like shape as shown in figure 2. The wall thickness between the inner periphery 34 and the outer periphery 34 is preferably equal throughout said cross-section. Said expandable part thus forms a pipe-like device preferably with room for a drilling fluid supply pipe 20 in the centre.

Symmetrical cross-sections for the expandable part 8 of the rock bolt 2 other than the one shown in figure 2 are also possible to use preferably with room for a drilling fluid supply pipe 20 located along the axis X of rotation of the expandable rock bolt part 8. Although symmetrical cross-sections are preferred, non-symmetrical cross-sections are also possible to use, preferably with room for a drilling fluid supply pipe 20 located along the axis X of rotation of the expandable rock bolt part 8. Due to the enhanced stability of the expandable part 8, it is also possible to arrange said drilling fluid supply pipe 20 radially displaced from said axis X of rotation but such an arrangement results in a more complicated and more expensive execution of the invention.

Figure 3 shows a view of a self-drilling rock bolt 2 according to figure 1. The self-drilling rock bolt 2 comprises, as already mentioned in connection with figure 1, at least three main parts: firstly, a connector part 4 intended for connecting the rock bolt 2 to a drilling apparatus 6 (not shown); secondly, an expandable part 8 intended to be expanded

after the rock bolt 2 has been fully inserted in position within a rock 10 (not shown) in order to lock said rock bolt 2 mechanically to the internal radial surface 12 of the hole 14 (not shown) drilled into the rock 10; and thirdly, a holder 17 for a drill bit 16 intended to be used for drilling the hole 14 into the rock 10. The symmetrical cross-section of the expandable rock bolt part 8 shown in figure 2 can also be seen here.

Claims

1. Self-drilling rock bolt comprising an intermediate expandable part (8) joined at its first end (at 7) to a connector part (4) and at its second end (at 9) to a drill bit unit (27), characterized in, that
- said connector part (4) abuts against the first axial end surface (7) of said expandable part (8) thereby forming a first contact region (5),
- said drill bit unit (27) abuts against the second axial end surface (9) of said expandable part (8) thereby forming a second contact region (15), and that
- said expandable part (8), said first contact region (5), and said second contact region (15) all have cross-sections that at least partly overlap each other when seen axially along said rock bolt (2), thereby allowing axial forces during a hammer drilling operation to propagate in an essentially axial direction (A) from said connector part (4) via said expandable part (8) into said drill bit unit (27).

2. Self-drilling rock bolt according to claim 1, characterized in, that
said drill bit unit (27) comprises a holder (17) for a drill bit (16) and a drill bit (16), respectively, and that said second end (at 9) of said intermediate expandable part (8) is joined to the holder (17).

3. Self-drilling rock bolt according to claim 1 or 2, characterized in, that
a drilling fluid supply pipe (20), with a first end opening (22) in the centre of rotation (24) of the connector part (4) and a second opening (26) in the drill

bit unit (27), extends from the connector part (4), through the inside the expandable part (8) and to the drill bit unit (27).

4. Self-drilling rock bolt according to claim 1 or 2, characterized in, that
a first end opening (22) is arranged through the centre of rotation (24) of the connector part (4) and a second opening (26) is arranged through the drill bit unit (27), and that the drilling fluid (18) is conveyed within the expandable part (8).

5. Self-drilling rock bolt according to one of the preceding claims, characterized in, that
both the outer periphery (32) and the inner periphery (34) of the expandable part (8) of said rock bolt (2) has a symmetrical cross-section.

6. Self-drilling rock bolt according to claim 5, characterized in, that
the cross-section of the expandable part (8) forms a cross-like shape having an inner channel (11) also with a cross-like shape.

7. Self-drilling rock bolt according to claim 6, characterized in, that
said inner channel (11) has room for a drilling fluid supply pipe (20).

8. Self-drilling rock bolt according to one of claims 5 to 7, characterized in, that
the wall thickness between the inner periphery (34) and the outer periphery (32) is equal throughout said cross-section.

9. Self-drilling rock bolt according to one of claims 1 to 4, characterized in, that
the expandable part (8) of said rock bolt (2) has a non-symmetrical cross-section.

10. Self-drilling rock bolt according to claim 9, characterized in, that
the non-symmetrical cross-section has room for a drilling fluid supply pipe (20) located along the axis (X) of rotation of the expandable rock bolt part (8).

11. Self-drilling rock bolt according to claim 10, characterized in, that
the non-symmetrical cross-section has room for a drilling fluid supply pipe (20) located radially displaced from the axis (X) of rotation of the expandable rock bolt part (8).

12. Self-drilling rock bolt according to one of the preceding claims, characterized in, that
said expandable part (8) is joined to said connector part (4) and said drill bit unit (27), respectively, by welding.

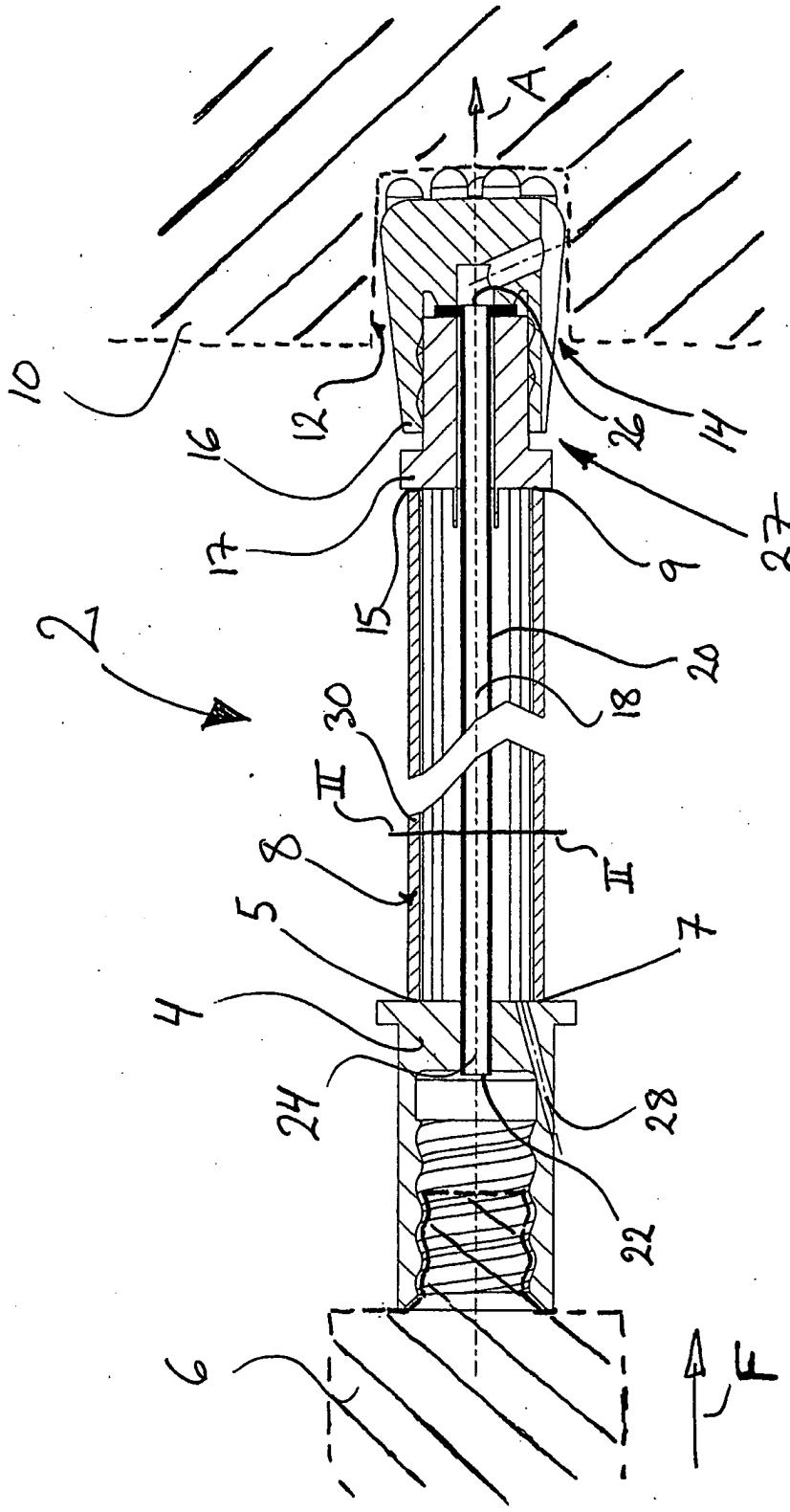

fig. 1

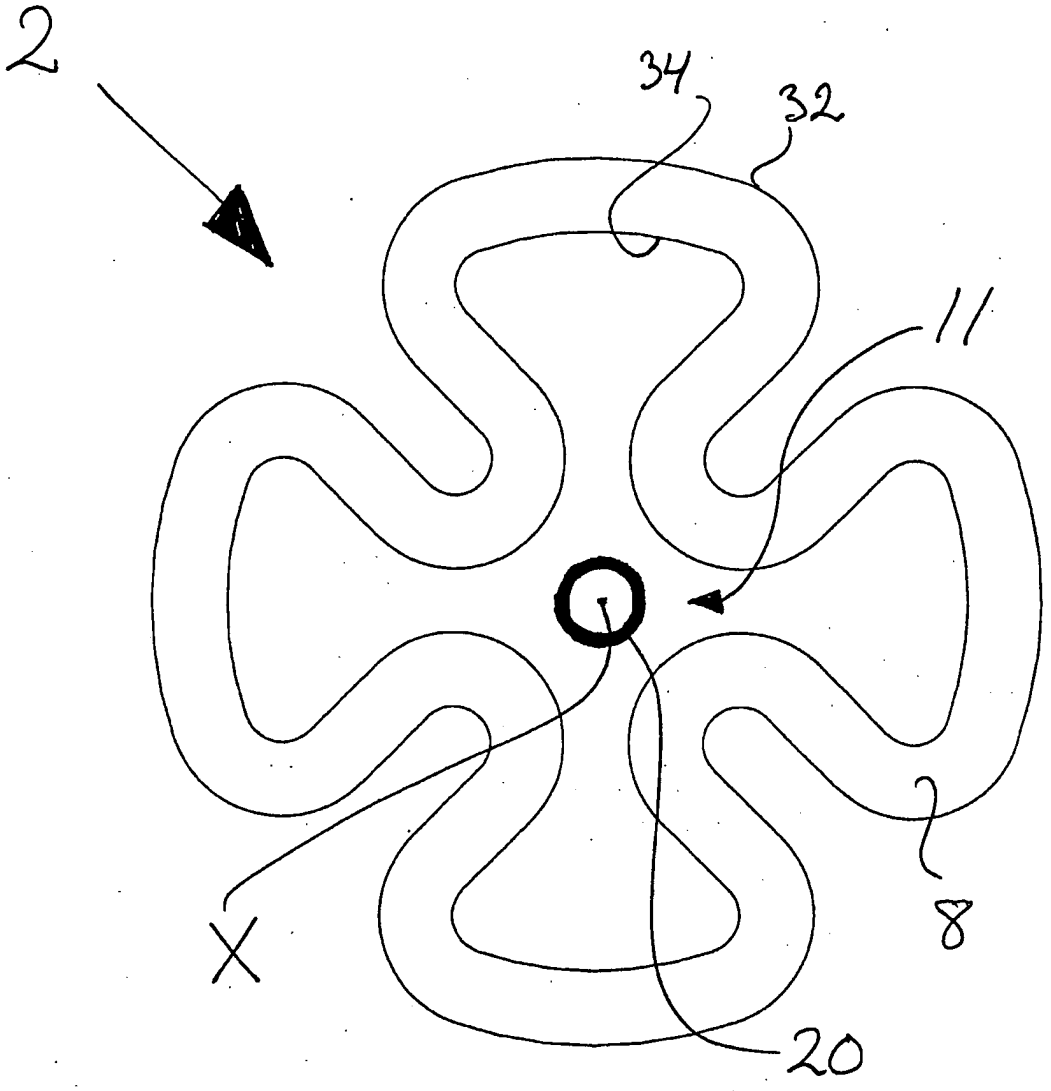

fig. 2

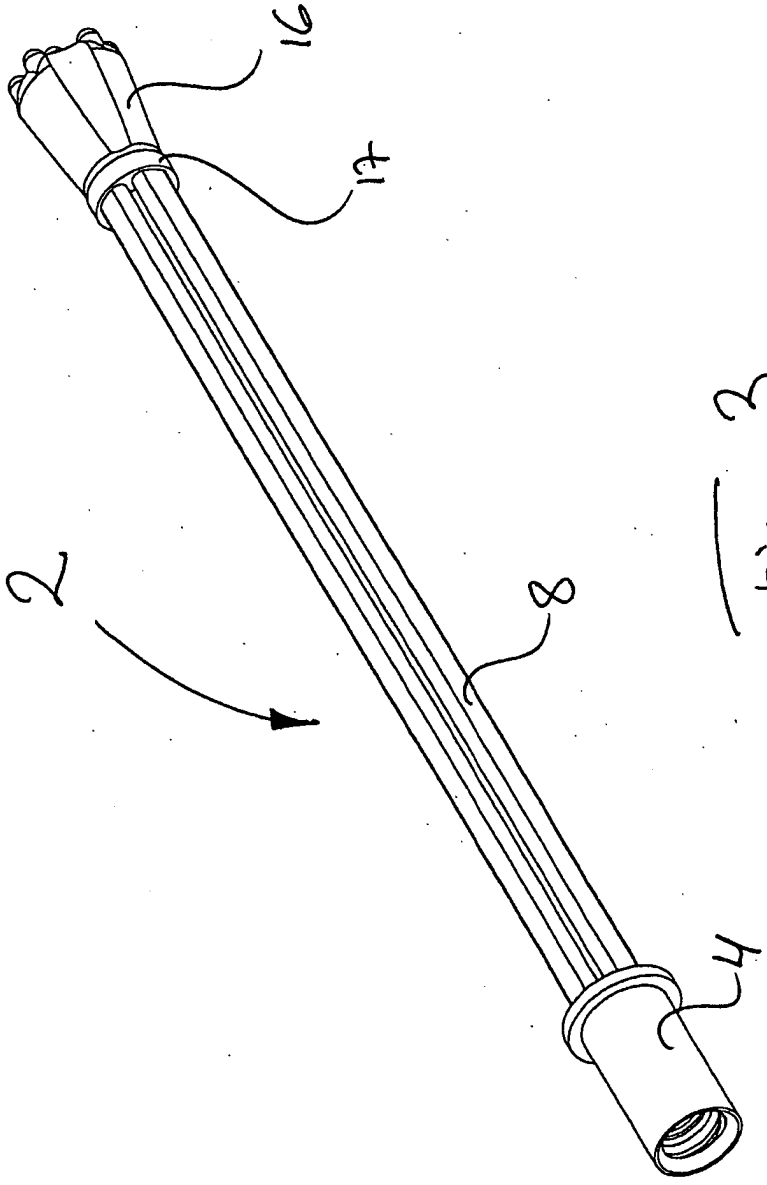

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/001536

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21D 21/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4024869 A1 (MAGYAR ALUMINIUMIPARI TRÖSZT), 14 February 1991 (14.02.1991) --	1-12
A	WO 0066873 A1 (RAERS CORPORATION PTY LTD), 9 November 2002 (09.11.2002) --	1-12
A	WO 03062599 A1 (TECHMO ENTWICKLUNGS- UND VERTRIEBS GMBH ET AL), 31 July 2003 (31.07.2003) --	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
1 February 2005	18 -02- 2005
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Bäcknert / MRo Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (January 2004)

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